Vegetation Sampling In
The Wild Horse Ridge Area

Appendix 3-F

VEGETATION SAMPLING IN THE WILDHORSE RIDGE AREA

1996

A Comparison Between:
The Proposed Disturbed Conveyor Corridor,
New Portal Area, and Reference Area

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1996

SCOPE

The purpose of this document is to describe and provide quantitative and qualitative data for an area that has been proposed for future disturbance by coal mining activities. An area chosen for comparison, and to represent the standard for revegetation success for the disturbed area once mining activities seize and the land is reclaimed, has also been studied.

INTRODUCTION

The CO-OP Mining Company has planned expansion to their mining operations in the Wildhorse Ridge area. Disturbance to plant communities would occur due to construction of a conveyor system and portal area.

Elevation of the study area ranged from 7,500 ft to 8,500 ft above sea level. The study area was located in Bear Canyon, a branch of Huntington Canyon in Emery County, Utah. General plant community types at and adjacent to the areas that are proposed for disturbance were: pinyon-

juniper, Salina wildrye, mountain brush, ponderosa pine, sagebrush/grass, and limited riparian communities.

METHODS

The State of Utah, Department of Natural Resources, Division of Oil, Gas and Mining (DOGM) provided guidelines for some of the sample methodologies used in this report. Quantitative and qualitative data were taken on the vegetation of the proposed disturbed and reference areas in the Wildhorse Ridge area. Sampling was conducted in early August 1996.

Proposed Disturbed Area

The area surveyed for disturbance was primarily along a proposed new conveyance corridor and terminates at a new portal area. Areas along the proposed route of the conveyor and portal were sampled. More information is given about the plant communities and provides additional insight about the sampling methods in the RESULTS section below.

Reference Area

A reference area to be used as a standard for revegetation success at the time of final reclamation was selected. The reference area was dominated by similar plant species as the proposed disturbed areas. The reference area was chosen to comply with guidelines provided by DOGM

and was estimated to have similar slopes, soils, species composition, precipitation, elevation and other environmental variables.

Due to the heterogeneity of the proposed disturbed area (see RESULTS, Proposed Disturbed Area), an exact duplication for a reference area was difficult to locate. One area was recommended for consideration by a DOGM biologist. This area was the site used for another reference area for previous disturbances by the CO-OP Mining Company (Showerhouse Reference Area), so quantitative data was available. When these data were compared to the preliminary field data, it appeared that the differences (especially for cover) would have been significant.

Another area was then considered for a reference area to the proposed disturbed areas. The area was much closer to the proposed disturbed areas (near an archeological site), but due to changes in exposure and soils (especially the proximity of the bedrock to the surface), cover would have obviously been significantly less than the proposed disturbed area.

A third area was considered that was also in relatively close proximity to the proposed disturbed areas, but was on the other side of the drainage with different exposure to the sun.. However, because the community was more similar and also had transitional attributes, it appeared to be the logical choice that most closely represented the areas chosen for potential disturbance. More information about this community is given in the RESULTS section of this document.

Transect and Quadrat Placement

Transect lines for sampling were placed randomly along the proposed conveyor corridor and portal areas. Stratified random placement of sampling quadrats were designed to provide *subjective sampling without preconceived bias.* Once the transect lines were placed, regular points were then marked on them. From these marks, a random number dictated the direction and distance to place the quadrats at right angles from the transect lines. Vegetation sampling methodologies between the proposed disturbed and the reference areas were consistent.

Cover and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition was also assessed from the quadrat data. Additional information recorded on the raw data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al. 1993).

Frequency

Frequency was calculated for each plant species and represents the relative number of times that a given species occurred in the square meter quadrats.

Woody Species Density

Density of woody plant species were recorded using the point quarter distance method (Cottom and Curtis 1956). In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual.

Sample Adequacy & Statistical Comparisons

As recommended by DOGM guidelines, sampling adequacy was calculated using formulas from Cochran (1977), with the goal of 80% confidence level with a 10% change in mean (two-tailed t-value was used). The formula used is given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Student's t-tests were employed to compare the proposed disturbed and reference areas of the sites for cover, and density. All sample means, standard deviations, and sample sizes were

included in this report to enable the reviewers to check or apply further statistical tests if desired.

Photographs

Color photographs of the sample areas were taken at the time of sampling and have been included with this report.

Raw Data

The raw data have been summarized on spreadsheets and have also been included in the Appendix.

RESULTS

Proposed Disturbed Area

The area planned for disturbance begins on a proposed conveyor corridor route. Near the beginning of this conveyor system, other small disturbance sites are also planned (i.e. topsoil stockpile area). The proposed new conveyor will continue up the canyon and terminate at a new portal site. Sample areas were chosen along the proposed route of the conveyor and in the portal area. Engineering designs for the conveyor show no disturbance is planned for the bottom of the drainage itself with the exception of one very small area that is less that 1 acre in size. Therefore,

sampling was focused on the proposed conveyor corridor (and not the drainage bottoms) to more accurately assess those areas that will most likely be disturbed. Much of the proposed corridor runs adjacent to an existing road, so some of the area that is proposed for new disturbance has already been somewhat disturbed previously. Sampling, however, was restricted to those areas that were not previously disturbed by the road or any other man-caused activities.

The proposed disturbed sites of the Wildhorse Ridge area were quite variable for several reasons. Most notably, the conveyor corridor has been designed to be placed near the bottom of the drainage and advances to a distance on one side or the other of the drainage (see PHOTOGRAPHS). With the changes in topography, soils, exposure and proximity to the drainage bottoms, there is a considerable amount of diversity in species and composition. Although the proposed disturbed areas were heterogeneous, they probably were not dissimilar enough in the appropriate parameters to warrant separating data for the summaries. However, the methods used to record and summarize these data provide opportunities to do so if found necessary in the future.

Total living cover (overstory plus understory) of the proposed disturbed sites of the Wildhorse Ridge area was estimated to be 42.50%. Understory comprised 34.00% of that cover (Table 1). The understory composition was dominated by grasses or provided 73.71% of the cover, whereas, woody species were 23.40% and forbs 2.89%, respectively (Table 1).

The dominant plant species was Salina wildrye (*Elymus salinus*) which comprised 15.83% cover,

followed distantly by needle-and-thread grass (*Stipa comata*), Utah Juniper (*Juniperus osteosperma*), smooth brome (*Bromus inermis*) and white fir (*Abies concolor*). For cover and frequency summaries, refer to Table 2.

Woody species densities were also estimated in the area. Total woody species density was estimated at 1,010 individuals per acre (Table 3). The dominant woody species by density were: big sagebrush (*Artemisia tridentata*), pinyon pine (*Pinus edulis*), black sagebrush (*Artemisia nova*), mountain mahogany (*Cercocarpus ledifolius*), and Utah juniper (*Juniperus osteosperma*).

Reference Area

As mentioned in the METHODS section above, several areas were considered to be used for future revegetation success standards. The area chosen comprised of plant communities transitional between the lower drainage area and the pinyon-juniper/grass areas commonly found on the upland slopes (see PHOTOGRAPHS). The transect lines were stratified to intentionally included some communities common near the drainage (i.e. conifers), pinyon-juniper stands, and the open interspaces between them where grasses were more common.

Total living cover of the reference area was estimated to be 46.25%, where most of it was provided by the understory at 37.25%. Like the proposed disturbed areas, grasses dominated the cover comprising 42.23% of the cover, but more equally represented by shrubs (35.39%) and forbs (22.37%). Total cover and understory composition summaries are shown on Table 5.

Again, similar to the proposed disturbed areas, the most common plant species was Salina wildrye (*Elymus salinus*), followed by corymbed buckwheat (*Eriogonum corymbosum*), rubber rabbitbrush (*Chrysothamnus nauseosus*) , bluegrass (*Poa pratensis*), and hoary aster (*Machaeranthera canescens*). For cover and frequency by species, refer to Table 6.

Density of woody species for the reference area proved to be higher than the proposed disturbed areas estimated at 1,405 individuals per acre (Table 7). Dominant plants for this parameter were corymbed buckwheat (*Eriogonum corymbosum*), Douglas fir (*Pseudotsuga menziesii*), pinyon pine (*Pinus edulis*), low rabbitbrush (*Chrysothamnus viscidiflorus*), and Utah juniper (*Juniperus osteosperma*).

DISCUSSION

Statistical Comparisons

Student's t-tests suggest that there was no statistical difference for cover when the proposed disturbance was compared with the reference area (Table 8). Although woody species density was quite high in both areas, statistical tests imply that the reference area was significantly greater than the proposed disturbed areas. As mentioned in the RESULTS, understory composition of the reference area was more equally represented by woody species, forbs and grasses.

Sensitive Plant Species

Mention should be made to the fact that there were several individuals of canyon sweetvetch (*Hedysarum occidentalis* var. *canone*) within the boundaries of the proposed disturbed area, especially on the slopes and small drainage ways near the beginning of the proposed conveyor (near the area where topsoil stockpiles and other disturbances are planned).

Although, not officially listed as "threatened" or "endangered", canyon sweetvetch is an endemic to the area and protection from disturbance is recommended.

TABLE 1: Total cover and composition summary for the proposed disturbed conveyor corridor of the Wildhorse Ridge area (1996).

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE
Overstory Cover (O)	8.50	14.61	30
Understory Cover (U)	34.00	11.79	30
Litter	23.17	13.87	30
Bareground	18.16	14.27	30
Rock	16.16	12.71	30
Total Living Cover (O+U)	42.50	10.31	30
UNDERSTORY COMPOSITION			
Woody spp.	23.40	28.39	30
Forbs	2.89	11.49	30
Grasses	73.71	29.12	30

TABLE 2: Species cover and frequency summary for the understory of the proposed disturbed conveyor corridor of the Wildhorse Ridge area (1996).

SPECIES	% MEAN COVER	STANDARD DEVIATIONS	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Abies concolor	1.33	5.62	30	10.00
Artemisia nova	1.33	3.86	30	13.33
Artemisia tridentata	0.67	2.13	30	10.00
Cercocarpus ledifolius	0.67	2.49	30	6.67
Echinocereus triglochidiatus	0.17	0.90	30	3.33
Gutierrezia sarothrae	0.17	0.90	30	3.33
Juniperus osteosperma	2.33	8.83	30	6.67
Opuntia polyacantha	0.40	1.28	30	10.00
Pinus edulis	0.83	2.61	30	10.00
Pseudotsuga menziesii	0.67	2.13	30	10.00
FORBS				
Erigeron sp.	0.10	0.54	30	3.33
Medicago sativa	0.83	4.49	30	3.33
Mirabilis linearis	0.17	0.90	30	3.33
GRASSES				
Agropyron cristatum	0.83	2.91	30	10.00
Bromus inermis	1.50	4.86	30	13.33
Elymus salinus	15.83	15.00	30	70.00
Poa pratensis	0.67	2.13	30	10.00
Stipa comata	4.83	0.92	30	26.67
Stipa hymenoides	0.67	2.49	30	6.67

TABLE 3: Woody species densities of the proposed disturbed conveyor corridor of the Wildhorse Ridge area (1996).

	NUMBER/ACRE	SAMPLE SIZE
Abies concolor	67.34	30
Artemisia nova	134.68	30
Artemisia tridentata	176.76	30
Ceratoides lanata	8.42	30
Cercocarpus ledifolius	123.26	30
Echinocereus triglochidiatus	8.42	30
Gutierrezia sarothrae	50.50	30
Juniperus osteosperma	109.43	30
Juniperus scopulorum	8.41	30
Opuntia polyacantha	42.09	30
Pinus edulis	159.93	30
Pinus ponderosa	33.67	30
Pseudotsuga menziesii	58.92	30
Salix sp.	25.25	30
TOTAL	1010.18	30

TABLE 5: Total cover and composition summary for the pinyon-juniper reference area of the Wildhorse Ridge area (1996).

TOTAL COVER	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE
Overstory Cover (O)	9.00	16.17	20
Understory Cover (U)	37.25	16.01	20
Litter	17.11	12.45	20
Bareground	12.24	8.54	20
Rock	24.40	15.65	20
Total Living Cover (O+U)	46.25	12.74	20
UNDERSTORY COMPOSITION			
Woody spp.	35.39	32.21	20
Forbs	22.37	24.54	20
Grasses	42.23	30.99	20

TABLE 6: Species cover and frequency summary for the understory of the reference area in the Wildhorse Ridge area (1996).

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
TREES & SHRUBS				
Abies concolor	1.50	4.77	20	5.00
Chrysothamnus nauseosus	2.75	5.58	20	25.00
Eriogonum corymbosum	4.00	7.35	20	30.00
Gutierrezia sarothrae	0.50	2.18	20	5.00
Juniperus osteosperma	0.50	2.18	20	5.00
Pinus edulis	1.00	3.39	20	10.00
Pseudotsuga menziesii	1.50	4.77	20	10.00
FORBS				
Artemisia ludoviciana	0.25	1.09	20	5.00
Castilleja chromosa	0.25	1.09	20	5.00
Circium sp.	1.75	2.86	20	30.00
Eriogonum sp.	0.25	1.09	20	5.00
Machaeranthera canescens	2.10	3.97	20	30.00
Townsendia incana	2.00	3.67	20	25.00
GRASSES				
Elymus salinus	14.65	14.99	20	75.00
Elymus spicatus	2.00	6.62	20	10.00
Poa pratensis	2.25	4.02	20	25.00

TABLE 7: Woody species densities of the pinyon-juniper reference area in the Wildhorse Ridge area (1996).

	NUMBER/ACRE	SAMPLE SIZE
Abies concolor	87.80	20
Artemisia tridentata	17.56	20
Chrysothamnus nauseosus	17.56	20
Chrysothamnus viscidiflorus	210.72	20
Eriogonum corymbosum	456.57	20
Gutierrezia sarothrae	35.12	20
Juniperus osteosperma	122.92	20
Pinus edulis	210.72	20
Pseudotsuga menziesii	245.84	20
TOTAL	1404.81	20

TABLE 8: Statistical summary sheet for the proposed disturbed and reference areas in the Wildhorse Ridge area (1996).

PROPOSED DISTURB AREAS				
Living Cover*	x=42.50	s=10.31	n=30	nMIN=9.64
Density**	x=6210.07	s=2958.79	n=30	nMIN=6.10
REFERENCE AREA				
Living Cover*	x=46.25	s=12.74	n=20	nMIN=12.43
Density	x=4465.09	s=1883.85	n=20	nMIN=5.40
STATISTICAL ANALYSES				
Living Cover	t=-0.514	df=21	SL=NS	
Density	t=2.336	df=48	SL=p<.05	

x = sample mean, s = sample standard deviation,
n = sample size, nMIN = minimum adequate sample,
NS = nonsignificant, t = Student's t-value, p=probability level
df = degrees of freedom, SL = significance level,
* represents understory and overstory cover combined.
** numbers represent the average point-to-individual distance squared (for densities, refer to RESULTS section).

COLOR PHOTOGRAPHS

PROPOSED DISTURBED AREAS OF WILDHORSE RIDGE

REFERENCE AREAS OF WILDHORSE RIDGE

APPENDIX

Raw Data

Wildhorse Ridge Conveyer
Proposed Disturbed
JP/Grass Conifer Transition
Exposure: SSW
Slope: 10 - 25 deg
Sample Date: 8 Aug 1996

1 thru 20 (West end of Conveyer, Road & Topsoil Storage)

	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
TREES & SHRUBS									
Artemisia tridentata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Artemisia nova	15.00	5.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00
Opuntia polyacantha	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gutierrezia sarothrae	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Pinus edulis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abies concolor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Juniperus osteosperma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudotsuga menziesii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Echinocereus triglochidiat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cercocarpus ledifolius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FORBS									
Erigeron sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mirabilis linearis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Medicago sativa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRASSES									
Poa pratensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
Stipa hymenoides	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
Stipa comata	0.00	25.00	5.00	45.00	5.00	0.00	0.00	0.00	0.00
Elymus salinus	15.00	0.00	0.00	0.00	0.00	5.00	55.00	50.00	35.00
Bromus inermis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agropyron cristatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COVER									
Understory (U)	35.00	30.00	35.00	45.00	5.00	5.00	55.00	50.00	40.00
Litter	5.00	20.00	20.00	25.00	90.00	90.00	43.00	20.00	20.00
Bareground	45.00	40.00	25.00	20.00	4.00	4.00	1.00	20.00	25.00
Rock	15.00	10.00	20.00	10.00	1.00	1.00	1.00	10.00	15.00
Overstory (O)	0.00	0.00	0.00	0.00	45.00	45.00	0.00	0.00	0.00
Total Living Cover (U+O)	35.00	30.00	35.00	45.00	50.00	50.00	55.00	50.00	40.00
% COMPOSITION (U)									
Shrubs	57.14	16.67	57.14	0.00	0.00	0.00	0.00	0.00	0.00
Forbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grasses	42.86	83.33	42.86	100.00	100.00	100.00	100.00	100.00	100.00
Litter+BG+Rock	65.00	70.00	65.00	55.00	95.00	95.00	45.00	50.00	60.00
Total Living Cover (U+O)	35.00	30.00	35.00	45.00	50.00	50.00	55.00	50.00	40.00
Litter w/ factor	5.00	20.00	20.00	25.00	47.37	47.37	43.00	20.00	20.00
Bareground w/factor	45.00	40.00	25.00	20.00	2.11	2.11	1.00	20.00	25.00
Rock w/factor	15.00	10.00	20.00	10.00	0.53	0.53	1.00	10.00	15.00

10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	10.00	5.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	10.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	0.00	0.00	30.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	0.00	10.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	5.00	15.00	35.00	0.00	10.00	0.00
25.00	25.00	10.00	0.00	30.00	0.00	0.00	0.00	15.00	25.00	30.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35.00	35.00	25.00	50.00	35.00	35.00	30.00	45.00	35.00	50.00	35.00
63.00	62.00	60.00	25.00	5.00	5.00	15.00	20.00	20.00	10.00	20.00
1.00	2.00	10.00	20.00	35.00	50.00	45.00	25.00	25.00	25.00	25.00
1.00	1.00	5.00	5.00	25.00	10.00	10.00	10.00	20.00	15.00	20.00
20.00	40.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55.00	75.00	35.00	50.00	35.00	35.00	30.00	45.00	35.00	50.00	35.00
28.57	28.57	60.00	90.00	14.29	85.71	6.67	22.22	42.86	30.00	14.29
0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	14.29	0.00	0.00
71.43	71.43	40.00	10.00	85.71	14.29	83.33	77.78	42.86	70.00	85.71
65.00	65.00	75.00	50.00	65.00	65.00	70.00	55.00	65.00	50.00	65.00
55.00	75.00	35.00	50.00	35.00	35.00	30.00	45.00	35.00	50.00	35.00
43.62	23.85	52.00	25.00	5.00	5.00	15.00	20.00	20.00	10.00	20.00
0.69	0.77	8.67	20.00	35.00	50.00	45.00	25.00	25.00	25.00	25.00
0.69	0.38	4.33	5.00	25.00	10.00	10.00	10.00	20.00	15.00	20.00

21 thru 30 (East end of Conveyer)

21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	Mean
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	0.00	0.00	2.33
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83
0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.83
20.00	0.00	5.00	30.00	25.00	15.00	15.00	5.00	25.00	15.00	15.83
10.00	25.00	5.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50
5.00	15.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83
45.00	40.00	40.00	35.00	25.00	15.00	25.00	35.00	25.00	25.00	34.00
15.00	40.00	10.00	20.00	5.00	25.00	30.00	45.00	45.00	10.00	29.43
5.00	5.00	25.00	5.00	20.00	10.00	15.00	10.00	5.00	20.00	18.90
35.00	15.00	25.00	40.00	50.00	50.00	30.00	10.00	25.00	45.00	17.67
0.00	0.00	0.00	0.00	0.00	30.00	35.00	10.00	10.00	10.00	8.50
45.00	40.00	40.00	35.00	25.00	45.00	60.00	45.00	35.00	35.00	42.50
22.22	0.00	0.00	0.00	0.00	0.00	0.00	85.71	0.00	40.00	23.40
0.00	0.00	62.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.89
77.78	100.00	37.50	100.00	100.00	100.00	100.00	14.29	100.00	60.00	73.71
55.00	60.00	60.00	65.00	75.00	85.00	75.00	65.00	75.00	75.00	66.00
45.00	40.00	40.00	35.00	25.00	45.00	60.00	45.00	35.00	35.00	42.50
15.00	40.00	10.00	20.00	5.00	16.18	16.00	38.08	39.00	8.67	23.17
5.00	5.00	25.00	5.00	20.00	6.47	8.00	8.46	4.33	17.33	18.16
35.00	15.00	25.00	40.00	50.00	32.35	16.00	8.46	21.67	39.00	16.16

Wildhorse Ridge Conveyer
Proposed Disturbed
JP/Grass Conifer Transition
Exposure: SSW
Slope: 10 - 25 deg
Sample Date: 8 Aug 1996

SDev	Freq	
		TREES & SHRUBS
2.13	10.00	Artemisia tridentata
3.86	13.33	Artemisia nova
1.28	10.00	Opuntia polyacantha
0.90	3.33	Gutierrezia sarothrae
2.61	10.00	Pinus edulis
5.62	10.00	Abies concolor
8.83	6.67	Juniperus osteosperma
2.13	10.00	Pseudotsuga menziesii
0.90	3.33	Echinocereus triglochidiatus
2.49	6.67	Cercocarpus ledifolius
		FORBS
0.54	3.33	Erigeron sp.
0.90	3.33	Mirabilis linearis
4.49	3.33	Medicago sativa
		GRASSES
2.13	10.00	Poa pratensis
2.49	6.67	Stipa hymenoides
10.92	26.67	Stipa comata
15.00	70.00	Elymus salinus
4.86	13.33	Bromus inermis
2.91	10.00	Agropyron cristatum
		COVER
11.79		Understory (U)
23.06		Litter
13.78		Bareground
14.28		Rock
14.61		Overstory (O)
10.31		Total Living Cover (U+O)
		% COMPOSITION (U)
28.39		Shrubs
11.49		Forbs
29.12		Grasses
11.79		Litter+BG+Rock
10.31		Total Living Cover (U+O)
13.87		Litter w/ factor
14.27		Bareground w/factor
12.71		Rock w/factor

CO-OP MINING
Wildhorse Ridge
Reference Area
PJ/Grasses
Exposure: NW
Slope: 29 deg
Sample Date: 8 Aug 1996

	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
TREES & SHRUBS									
Abies concolor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudotsuga menziesii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pinus edulis	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eriogonum corymbosum	15.00	0.00	25.00	0.00	20.00	0.00	5.00	0.00	0.00
Gutierrezia sarothrae	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysothamnus nauseosu	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	10.00
Juniperus osteosperma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FORBS									
Townsendia incana	10.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00
Machaeranthera canesce	0.00	0.00	5.00	10.00	0.00	0.00	0.00	0.00	0.00
Castilleja chromosa	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
Circium sp.	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	5.00
Artemisia ludoviciana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eriogonum sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRASSES									
Poa pratensis	5.00	10.00	0.00	10.00	0.00	0.00	10.00	10.00	0.00
Elymus salinus	25.00	35.00	0.00	5.00	25.00	35.00	35.00	55.00	10.00
ymus spicatus	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00	25.00
COVER									
Understory (U)	60.00	55.00	55.00	35.00	50.00	40.00	55.00	65.00	50.00
Litter	10.00	10.00	15.00	5.00	5.00	15.00	10.00	25.00	25.00
Bareground	20.00	10.00	5.00	5.00	10.00	5.00	15.00	5.00	5.00
Rock	10.00	25.00	25.00	55.00	35.00	40.00	20.00	5.00	20.00
Overstory (O)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Living Cover (U+O)	60.00	55.00	55.00	35.00	50.00	40.00	55.00	65.00	50.00
% COMPOSITION (U)									
Shrubs	33.33	0.00	63.64	0.00	40.00	0.00	18.18	0.00	20.00
Forbs	16.67	18.18	9.09	57.14	10.00	12.50	0.00	0.00	10.00
Grasses	50.00	81.82	27.27	42.86	50.00	87.50	81.82	100.00	70.00
Litter+BG+Rock	40.00	45.00	45.00	65.00	50.00	60.00	45.00	35.00	50.00
Total Living Cover (U+O)	60.00	55.00	55.00	35.00	50.00	40.00	55.00	65.00	50.00
Litter w/ factor	10.00	10.00	15.00	5.00	5.00	15.00	10.00	25.00	25.00
Bareground w/factor	20.00	10.00	5.00	5.00	10.00	5.00	15.00	5.00	5.00
Rock w/factor	10.00	25.00	25.00	55.00	35.00	40.00	20.00	5.00	20.00

10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	20.00
0.00	0.00	0.00	10.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	0.00
5.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	2.00	5.00	0.00	0.00	15.00	0.00	0.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	5.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	5.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	8.00	10.00	0.00	15.00	10.00	5.00	0.00	0.00	10.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.00	35.00	30.00	10.00	20.00	25.00	25.00	10.00	25.00	25.00	45.00
5.00	5.00	25.00	45.00	45.00	5.00	65.00	25.00	30.00	65.00	5.00
20.00	40.00	20.00	20.00	10.00	15.00	5.00	40.00	25.00	5.00	10.00
45.00	20.00	25.00	25.00	25.00	55.00	5.00	25.00	20.00	5.00	40.00
0.00	0.00	0.00	40.00	0.00	0.00	25.00	50.00	30.00	35.00	0.00
30.00	35.00	30.00	50.00	20.00	25.00	50.00	60.00	55.00	60.00	45.00
66.67	57.14	33.33	100.00	0.00	0.00	80.00	0.00	80.00	60.00	55.56
33.33	20.00	33.33	0.00	25.00	60.00	0.00	100.00	20.00	0.00	22.22
0.00	22.86	33.33	0.00	75.00	40.00	20.00	0.00	0.00	40.00	22.22
70.00	65.00	70.00	90.00	80.00	75.00	75.00	90.00	75.00	75.00	55.00
30.00	35.00	30.00	50.00	20.00	25.00	50.00	60.00	55.00	60.00	45.00
5.00	5.00	25.00	25.00	45.00	5.00	43.33	11.11	18.00	34.67	5.00
20.00	40.00	20.00	11.11	10.00	15.00	3.33	17.78	15.00	2.67	10.00
45.00	20.00	25.00	13.89	25.00	55.00	3.33	11.11	12.00	2.67	40.00

CO-OP MINING
Wildhorse Ridge
Reference Area
PJ/Grasses
Exposure: NW
Slope: 29 deg
Sample Date: 8 Aug 1996

Mean	SDev	Freq	
			TREES & SHRUBS
1.50	4.77	5.00	Abies concolor
1.50	4.77	10.00	Pseudotsuga menziesii
1.00	3.39	10.00	Pinus edulis
4.00	7.35	30.00	Eriogonum corymbosum
0.50	2.18	5.00	Gutierrezia sarothrae
2.75	5.58	25.00	Chrysothamnus nauseosus
0.50	2.18		Juniperus osteosperma
			FORBS
2.00	3.67	25.00	Townsendia incana
2.10	3.97	30.00	Machaeranthera canescens
0.25	1.09	5.00	Castilleja chromosa
1.75	2.86	30.00	Circium sp.
0.25	1.09	5.00	Artemisia ludoviciana
0.25	1.09	5.00	Eriogonum sp.
			GRASSES
2.25	4.02	25.00	Poa pratensis
14.65	14.99	75.00	Elymus salinus
2.00	6.20	10.00	Elymus spicatus
			COVER
37.25	16.01		Understory (U)
22.00	18.87		Litter
14.50	10.59		Bareground
26.25	14.57		Rock
9.00	16.17		Overstory (O)
46.25	12.74		Total Living Cover (U+O)
			% COMPOSITION (U)
35.39	32.21		Shrubs
22.37	24.54		Forbs
42.23	30.99		Grasses
62.75	16.01		Litter+BG+Rock
46.25	12.74		Total Living Cover (U+O)
17.11	12.45		Litter w/ factor
12.24	8.54		Bareground w/factor
24.40	15.65		Rock w/factor

BIOMASS PRODUCTION OF THE WILDHORSE RIDGE AREA

1999

A Comparison Between:
The Proposed Disturbed Conveyor Corridor,
New Portal Area, and Reference Area

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Report Date: November 1999
Fieldwork Date: August 1999

BIOMASS PRODUCTION OF THE WILDHORSE RIDGE AREA

1999

SCOPE

The purpose of this report is to provide biomass productivity for the plant communities in the Wildhorse Ridge area that are proposed for disturbance by the CO-OP Mining Company. Biomass production data for a Reference Area have also been submitted.

INTRODUCTION

Previously, vegetation sampling was conducted in August 1996 as a means to quantify plant communities that could be impacted by a proposed mine expansion by the CO-OP Mining Company. The planned expansion of their mining operations is located in the Wildhorse Ridge area. Disturbance to plant communities would occur due to construction of a conveyor system and portal area. A final report was provided to the CO-OP Mining Company in April 1997 that showed results from the vegetation sampling (see "*Vegetation Sampling in the Wildhorse Ridge Area: 1996*").

General descriptions of the study areas and selection of the Reference Area were discussed in the 1996-97 report and will not be described again in this report. The purpose of this report is to provide additional quantitative data to augment the data in the earlier report. Quantitative data

reported in the 1996-97 report included total cover, cover by species, understory composition, frequency and woody species density. This report provides results from annual biomass productivity for the area proposed for disturbance by expansion of the current mining activities. It also provides data for Reference Area that has been chosen as a revegetation success standard at the time of final reclamation. Justifications for selection of the Reference Area were outlined in the 1996-97 report.

METHODS

The State of Utah, Department of Natural Resources, Division of Oil, Gas and Mining (DOGM) provided guidelines for some of the sample methodologies used in this report. Productivity data were taken on the vegetation of the proposed disturbed and Reference Area in the Wildhorse Ridge area. Sampling was conducted in August 1999.

Proposed Disturbed Area

The area surveyed for disturbance was primarily along a proposed new conveyance corridor and terminates at a new portal area. Areas along the proposed route of the conveyor and portal were sampled.

Transect and Quadrat Placement

Transect lines for sampling production were placed randomly along the proposed conveyor corridor and portal areas. Stratified random placement of sampling quadrats were designed to provide *subjective sampling without preconceived bias*. Once the transect lines were placed, regular points were then marked on them. From these marks, a random number dictated the direction and distance to place the quadrats at right angles from the transect lines. Vegetation sampling methodologies between the proposed disturbed and the reference areas were consistent with each other and also with the 1996 methods described in the 1997 report.

Production Measurements

Total annual biomass production was measured by clipping, drying and weighing current annual growth. "Double sampling" using four quadrats estimated around the clipped and weighed plot was implemented.

Photographs

Color photographs of the sample areas were taken at the time of sampling, but have *not* been included in this report. These photographs are available upon request.

RESULTS

Proposed Disturbed Area

Annual biomass production for the area proposed for disturbance in the conveyor and portal areas was 125.31 pounds and 122.37 pounds per acre for the herbaceous and woody species, respectively. The total annual biomass for the proposed disturbed area was 247.68 pounds per acre (Table 1).

Reference Area

Total annual biomass production for the Reference Area or area chosen to be the standard of success at the time of final reclamation was 596.32 pounds per acre. Herbaceous production was estimated to be 286.17 pounds, whereas the woody plants species were 310.15 pounds per acre (Table 2).

DISCUSSION

Although the Reference Area productivity estimates were significantly higher than the proposed disturbed areas, the Reference Area continues to be an appropriate standard for revegetation success for reasons described in the aforementioned report, "*Vegetation Sampling in the Wildhorse Ridge Area: 1996*".

TABLE 1: Dry weight annual production in 1999 for the vegetation of the proposed disturbed conveyor system and portal areas in the Wildhorse Ridge vicinity.

LIFEFORM	LBS/ ACRE	STANDARD DEVIATION	SAMPLE* SIZE
Herbaceous	125.31	225.70	20(100)
Woody Spp.	122.37	234.70	20(100)
TOTAL PRODUCTION	247.68	287.31	20(100)

* Sample size shows the number of sample locations. The number of estimates recorded including "double sampling" is shown in parentheses.

TABLE 2: Dry weight annual production in 1999 for the Reference Area in Wildhorse Ridge vicinity.

LIFEFORM	LBS/ ACRE	STANDARD DEVIATION	SAMPLE* SIZE
Herbaceous	286.17	182.92	20(100)
Woody Spp.	310.15	463.58	20(100)
TOTAL PRODUCTION	596.32	407.78	20(100)

* Sample size shows the number of sample locations. The number of estimates recorded including "double sampling" is shown in parentheses.